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ABSTRACT

The rationale for determining the content sequence of the leadership course developed for the United States Naval Academy by Westinghouse Learning Corporation (the final report appears under EM 010 418, EM 010 419, and EM 010 484) is discussed. Each of several theoretical bases for sequencing is discussed and sample applications of the rationale are presented. EM 010 418 through EM 010 447 and EM 010 451 and EM 010 512 are related documents. (Author/RH)

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LEADERSHIP COURSE - PHASE I

SEQUENCING RATIONALE

CONTRACT NO. N00600-68-C-1525

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March 19, 1969

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SEQUENCING RATIONALE

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ABSTRACT

This paper presents the rationale for determining the content sequence for the leadership course being developed for the United States Naval Academy. Each of several theoretical bases for sequencing is discussed and sample applications of the rationale are presented.

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_____

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SEQUENCING RATIONALE

1.0 Introduction

Two general kinds of "sequences" must be constructed in the development of any course of instruction. The first is the Content Sequence, which concerns the organization of the subject matter; the second is the Procedural Sequence, which concerns the organization of the instructional presentation. To be sure, there are interactions at every stage of course development between content and procedure; the content arrangement often determines elements of the instructional methods, and an analysis of teaching methods may suggest a revised ordering of the subject matter. However, because the two sequences are constructed more or less independently - with the content specified and organized before the instructional procedures are designated - it is both possible and desirable to discuss them separately, and to indicate at the appropriate places where their developments intersect.

This report is an analysis of the rationale for sequencing the content of the Naval Leadership Course.[1] WLC considers the content organization to be a critical factor in the course development. The "sequencing rationale," derived from contemporary educational and psychological theory, and supported by consider-

[1] Procedural (or instructional) sequencing will be discussed in the Course Strategy Document (TP. 6.4).

able experimental evidence, has served as the logical basis for the content analysis which WLC researchers and writers have undertaken.

1.1 Definitions of Content and Sequence

The content of a course may be defined as (1) the set of behaviors and capabilities which the learner is expected to achieve as a result of the instructional experience, and (2) the specific form and type of examples, rules, generalizations and applications through which the student achieves these behaviors and capabilities. As Evans (1968) has pointed out, it is not sufficient to specify content solely in terms of behavioral objectives, because different students may achieve the same objective by different means (i.e., by learning different rules and examples; by exposure to different training stimuli in different patterns, etc.). The content must be defined in terms of both student-performance measures and elements of the task, i.e., what the student will accomplish and by what path he will accomplish it.

The specification of content is thus a very elaborate, detailed process. However, since the learning "steps" are derived from the objectives of the course, WLC may describe the content sequence solely in terms of the objectives; that is, the content sequence may be defined as the planned arrangment of behavioral objectives in the order of their expected accomplishment.

1.2 The Importance of Content Sequencing

Briggs (1968, p. 5) has clearly stated the "educational importance of the sequencing problem:"

> ...if all the elements of skill and knowledge a student is to acquire during a given course of instruction are independent one from another (that is, if the learning of one element does not facilitate the learning of another), then the different elements could just as well be taught in any arbitrary or random sequence; but if the elements are dependent one upon another (that is, if the learning of one element transfers, thus facilitating the learning of another), then a careful sequencing of elements in terms of the direction of such transfer should be more effective than a random sequence.

Because the content sequence determines to a large extent how a course is organized, it is reasonable to believe that the sequence may contribute substantially to the efforts of the instructional experience in producing the desired behavior changes. Such a suggestion has been supported by a number of recent studies (e.g., Gagne and Paradise, 1961; Gagne, Mayor, Garstens and Paradise; 1962; Newton and Hickey, 1965).

To paraphrase Briggs (1968, p. 107), the value of planned content sequencing is supported by the experimental finding that learning progresses better under some sequences than under others. There is presently an intense research effort to examine those sequencing variables which significantly affect the efficiency of instructional procedures; it is WLC's intent to utilize what information is now available, so that the content sequence will facilitate the instruction of Naval Leadership at Annapolis.

2.0 The Basis for Content Sequencing - The Hierarchical Structure of Learning

A fundamental concept underlying the development of a valid and useful sequencing rationale is that the acquisition of learned behaviors may require prerequisite capabilities of other, "subordinate" behaviors. This idea, that new learning is built upon prior learning, is a basic element of many recent educational theories. Although the theories often differ in their description of the learning process, in their specific terminology, and in their emphasis on particular aspects of the instructional situation, they each describe human learning as a hierarchical accumulation of acquired behaviors. The word "hierarchy" is used, in the broadest sense, to identify the structural arrangement of a learning experience by specifying the relationships between the prerequisite and terminal behaviors. A brief discussion of three theoretical positions may help to clarify the concept of learning hierarchy as related to content sequence.

Bloom (1954), in describing the organization of his taxonomy of behavioral objectives, wrote:

> Although it is possible to conceive of these major classes (of behavioral objectives) in several different arrangements, the present one appears to us to represent something of the hierarchical order of the different classes of objectives. As we have defined them, the objectives in one class are likely to make use of and be built on the behaviors found in the preceding classes in this list.

Gagne has developed a logic of planned content sequencing based on both task and performance variables. In his book, The Conditions of Learning (1965), Gagne described eight types of learning, "defined in terms of the conditions required to bring

them about. These learning types are arranged in order from the most "simple" (stimulus-response learning) to the most complex (application of principles); they are related to each other in that for a given unit of content the acquisition of the simpler types of behaviors is a prerequisite for learning the more complex tasks:

> The most important class of condition that distinguishes one form of learning from another is its initial state; in other words, its prerequisites. The conditions for chaining, for example, require that the individuals have previously learned stimulus-response connections available to him, so that they can be chained. If this condition is not met, one finds oneself dealing with conditions for establishing these prerequisite Ss ⟶ R's and thus likely to draw incorrect conclusions about chaining, itself. This generalization, applied to the (eight) varieties of learning...may be briefly stated as follows:
>
> Problem solving (type 8)
> which requires as prerequisites:
>
> Principles (type 7),
> which require as prerequisites:
>
> Concepts (type 6),
> which require as prerequisites:
>
> Multiple discriminations (type 5),
> which require as prerequisites:
>
> Verbal associations (type 4) or
> other chains (type 3); etc.

Gagne has related the hierarchy of learning type to the process of learning by attempting to show that "each variety of learning...begins with a different state of the (student) and ends with a <u>different capability for performance</u>."

In other words, "each of the eight varieties of learning conditions...establishes a different kind of capability in the learner," so that learning may be described as the hierarchical achievement of learned capabilities. The acquisition of knowledge would therefore be defined as the achievement of "an inferred capability which makes possible the successful performance of a class of tasks that could not be performed before the learning was undertaken." (Gagne, 1962, p. 355)

Briggs (1968) has echoed Gagne's conceptualization of the learning process as a hierarchical acquisition of learned capabilities. He used the term "subordinate competencies" to describe those capabilities which must be achieved before a particular task can be mastered.

In a consulting report submitted to the USNA, Briggs and Tallmadge (1967) described the necessity of studying and analyzing the content and objectives "for the purpose of determining the sequence of instruction. Included in this analysis would be a detailed specification of the 'prerequisite competencies', referring to the subordinate skills and knowledges which must be acquired in particular sequences in order to attain the mastery of a particular behavioral objective." These suggestions were echoed in the Request for Proposal.

3.0 Behavioral Hierarchies and Course Structures

The description of learning as a hierarchical attainment of acquired capabilities has direct application to the planned sequencing of content, since this sequence has already been defined as the ordered arrangement of behavior objectives, and since these objectives are defined as the expected behaviors acquired by the learner as a result of the instructional experience. The task of content sequencing thus involves analyzing the behavioral objectives to determine their dependent and independent relationships, so that the achievement of prerequisite competencies enables the student to attain succeeding behaviors. The rationale for such an analysis has been stated by Gagne (1965):

> The existence of capabilities within the learner that build on each other... provides the possibility of the planning of sequences of instruction. If problem solving is to be done... then the... principles to be applied to the problem must be previously learned; if these principles in turn are to be learned, one must be sure there has been previous acquisition of relevant concepts; and so on. Thus it becomes possible to "work back" from any given objective of learning to determine what the prerequisite learning must be; if necessary, all the way back to simple verbal associations and chains...When such an analysis is made, the result is a kind of map of what must be learned.

It is this "map of what must be learned" which represents the basic structure of the course. As defined by Briggs (1968), course "structure" is "the description of dependent and independent relationships among component competencies, arranged so as to imply when sequencing can be random or optional and when

sequencing must be carefully planned, on the basis that transfer will be optional in order to build up from simple skills to more complex ones."

Briggs (1968) has developed a classification scheme for a number of possible types of structure:

1. A flat structure. This phrase is employed to describe the organization or structure of the course when it does not appear to matter in what sequence the instruction for the various major objectives or subobjectives is arranged. For a course with a flat structure one could either conduct the instruction in a random sequence or in any arbitrarily chosen order which one prefers. The significance of such a structure would be that the competencies gained in reaching each objective are independent from the competencies gained in reaching all other objectives. It is conjectured that if a course is well analyzed for the purpose of deciding upon the sequencing of the instruction, a truly flat structure will seldom be encountered. When one does encounter an apparently flat structure of a course, one can question the value of the course, or perhaps the objectives should be restudied to make sure that they are in fact behavioral objectives rather than content objectives (see Briggs et al., 1967). An example might be a foreign language course involving written vocabulary, but no sentence translation or speaking. Another might be a history course limited to learning dates on which events occurred.

2. A vertical structure. This term is applied when there is one fixed best sequence, in which Objective A should first be taught, then Objective B, and then C, and so on. A course having such a vertical structure thus contains no "lateral transfer" among competencies which would otherwise appear at the same level in a hierarchical structure. It is believed that this type of structure would also be encountered infrequently for a course as a whole, although it may be encountered sometimes in planning the instruction within a single course objective. This type of structure then has only one competence per level.

3. The hierarchical structure. This kind of structuring is represented by a pyramid-shaped arrangement of the objective of the course in which the objective at the top of the pyramid is a global, total course objective, and the subordinate objectives are arranged in layers. A hierarchical structure implies that all of the competencies within a layer should be taught before instruction for the next layer is begun (because vertical transfer is expected), although there may be options in the sequencing of the instruction within a layer (if lateral transfer is not expected). A hierarchical structure is a frequently-reported structure for carefully analyzed learning objectives or tasks.

4. Mixed structure. This would be illustrated by a course in which two or more major parts can be taught in random order, but where hierarchies may exist within the parts. This is called "parallel learning" by Ausubel and Youssef (1963). A special case might exist as for foreign language, where vocabulary and sentence structure are both involved. Just how vocabulary and sentence structure are time phased would permit at least these options, desirable or not: (a)teach all the vocabulary, then sentence structure; (b) teach some vocabulary and some sentence structure, using familiar words only in the latter; (c) same as b, but introduce new words in the course of instruction on sentence structure. There may be instances of the reverse situation, where sequence is important among major objectives but not in the learning of the individual objective.

5. The special case of a flat structure requiring spiral sequencing of instruction. This type of structure is sometimes encountered when the major objective of a course is that the student learn to solve complex problems by analyzing each of several major components in a problem. An example of this has been encountered in discussions with subject-matter experts on learning to analyze foreign policy problems. Subject-matter experts in this area indicate that in making each foreign policy decision encountered in practice, it is necessary to analyze each of a dozen important factors going into each foreign policy decision in such a way as to appraise each factor individually and also to arrive at the best trade-off decision as relating to each of the 12 factors. In arranging instruction in this case one might proceed first by teaching some individual concepts and principles needed later in analyzing each of

> the 12 factors to be considered in making a foreign policy decision; this constitutes the first "spiral." These 12 introductory sequences can be taught in any order. Next, a problem would be presented to the student in which the analysis is given to him for 11 factors, and he solves the problem by analyzing the 12th factor and arriving at a decision based on use of the analyses provided for the other 11 (second spiral). In the next problem given, two factors would essentially be left blank, requiring the student to consider the supplied information on 10 factors in terms of his own analysis for the other two factors. By spiraling the instruction the programmer or experimenter continues to supply an increasingly small part of the total solution, while the learner develops the competency to solve an increasingly large part of the problem. After a dozen such cycles or spirals he has acquired the capability to analyze a new problem by analyzing all 12 of its components, and making the decision for action. While there might conceivably be a better way to approach such instruction, the spiral sequencing at least represents one logical approach for this type of problem. This type of learning structure has been discussed by Glaser (1962) and by Bruner (1963), who refers to this sequencing procedure as "revisiting," or learning which "turns back on itself." In the "RULEG" system of programing discussed by Glaser, a wider variety of examples or finer discriminations may be accomplished by the latter spirals.

Although Briggs has outlined a number of possible structural arrangements of behavioral objectives, both he and Gagne have hypothesized that the analysis of most courses of instruction would reveal a hierarchical structure, "represented by a pyramid-shaped arrangement of the objectives... in which the objective at the top of the course is a global, total objective, and the subordinate objectives are arranged in layers." (Briggs, 1968, p. 12). Gagne (1965) has suggested that "the subjects of school instruction possess hierarchical organizations with respect to required types of learning. Each can be analyzed to reveal prerequisite learnings that grow progressively simpler as one works downward from principles to Ss——→ R connections.

And Briggs (1968) has cited a number of studies which have:

> ...supported the view that many courses or portions of them, when analyzed carefully, display an inferred hierarchical structure whose validity can be supported by comparing sequences of instruction designed to follow the hierarchy with some other strategy of sequencing. Several experiments provided various kinds of evidence of the validity of the hierarchy, because when learning was sequenced accordingly, learning progressed better than under other sequencing procedures.

3.1 The Levels of Behavioral Objectives

"In a general sense," Briggs (1968, p. 4) wrote, "an analysis of the behavioral objectives for any course of instruction should be the starting point. A study of the extent of apparent interdependence or independence among such objectives should suggest the latitude one might have in blocking out the molar units of instruction as to their place in the course, and an effort to determine the internal structure for each objective in terms of structures which appear to be vertical, flat, or hierarchical in nature should provide a starting point for considering the more molecular structure of the course."

Briggs' suggestion, that the more general and comprehensive objectives should first be identified and sequenced, has been extended by Stolurow and Brennan (1968). According to these authors, statements of behavioral objectives can be made at two basic levels. The first level is the macro-level of objective, which roughly corresponds to behaviors brought about in students as the result of studying relatively large areas of the content.

The second level is the micro-level of objective, which corresponds to behaviors brought about in students as a result of studying relatively specific elements of the content.

Stolurow and Brennan (1968) define macro-objective as the overall, large-scale instructional intention of the objective or test item. Macro-content refers to the general section of the course to which the objective or test item is aimed. In this case, macro-content refers to the clustering of content into meaningful course Chapters (or Parts). For example, a Part concerned with communication should have as the basic objective the development of skills in communication as evidenced by the ability to appropriately apply principles of communication in new problem-solving situations. Macro-objectives will be stated as expected changes in student behavior which occur as the result of interaction with Parts or macro-content. They will not necessarily include the specific activity the student must perform to demonstrate his mastery of the objective.

Micro-objectives, on the other hand, will be stated as terminal behaviors the student will engage in, and will immediately imply his degree of mastery of the objective. These objectives will contain a verb ("virile verb") which specifies the exact performance expected of the student in relation to the specific content measured.

Stolurow and Brennan (1968) define micro-objective as a statement of something the learner will "do". The rationale for stating the objective in this way is that the learner's behavior can be observed and measured, i.e., tested (Mager, 1962; Loree, 1965; Gagne, 1965). Micro-content is defined as the very specific area

of knowledge with which the test item or objective is concerned. It is the specific object of the "do" statement. Stolurow and Brennan note a major distinction between micro- and macro-content in that micro-content is always found in a typical statement of an educational objective whereas macro-content is often merely implied. The value of stating the behavioral objectives at both levels is that the macro-objective may be used to describe the general course structure, and the micro-objectives may be sequenced independently within macro-content units.

Considering the theoretical statements which have been discussed, WLC is now ready to examine their applications to the sequencing of the Naval Leadership Course.

4.0 The Development of the Leadership Course Content Sequence

4.1 The Specification and Sequencing of Macro-Objectives

As already stated, the specification of behavioral objectives is a preliminary task in the development of the content sequence (primarily because the sequence may be defined as an ordered arrangement of the objectives).

The USNA subject matter expert, who is also the Project Manager, had provided, as the "core content," 81 "critical factors" abstracted from the film script of General Order 21 and from the 41 Critical Behavior Categories contained in NAVPERS 92224A.

W L C's next undertaking, therefore, was to categorize this material into individual topic units, each defined (in behavioral terms) as a macro-objective. It should be mentioned that there were a number of advantages in identifying these macro-objectives, besides those discussed earlier in this paper:

a. It was possible to identify the intent of the course in a few, rather than many, general statements.

b. The macro-objectives lend direction to the sequencing of major aspects of course content and to the sequencing of instructional procedures.

c. The macro-objectives can themselves be defined by a set of micro-objectives. This facilitates the efficient classification of content material within topic units, and also aids in planning the sequence of the units.

d. The macro-objectives can be tested to determine the effectiveness of the instructional system.

e. Tests, based on macro-objectives, will also give some indication of long-term retention of the principles of leadership.

After analyzing the content and the critical factors provided by the SME, WLC, in conjunction with the Naval Academy, categorized the content into twelve topic units (or domains) called Parts (or Chapters). Each of these eleven parts was represented by a macro-objective; the last part was designated as a Summary and Review.

These macro-objectives were then sequenced in the manner suggested by the theories which have already been reviewed. The basic inferred course structure, as generated by the sequencing of macro-objectives, was found to be a hierarchical arrangement of the Parts. Figure 1 illustrates this hierarchical structure.

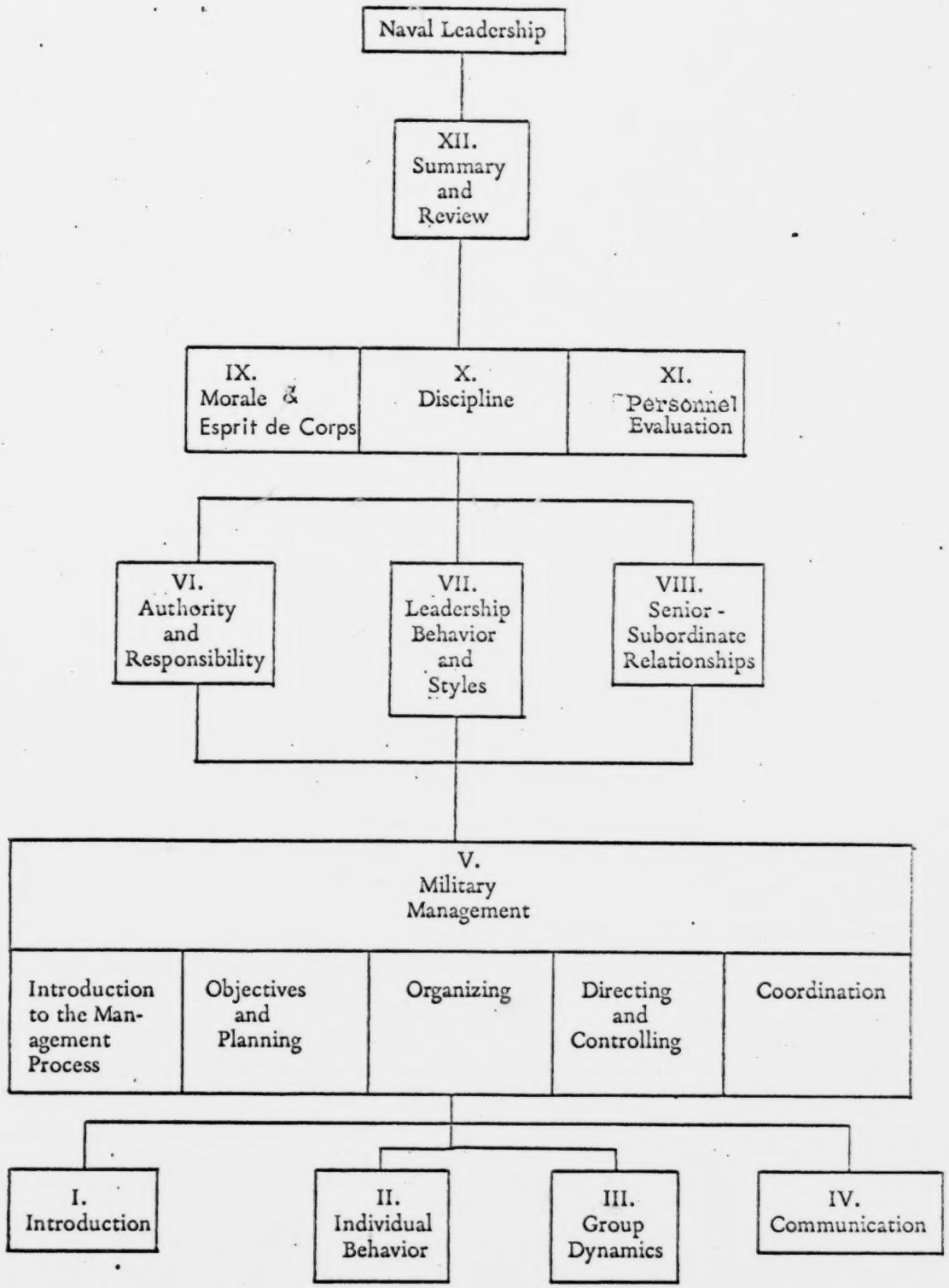

Fig. 1 Hierarchical structure of the topic units (Parts) of the Naval Leadership Course

It can be seen that the course is organized into four (horizontal) levels, each level containing one or more topic units. The achievement of the macro-objectives at each of the levels is prerequisite to the acquisition of knowledge in the next higher level. Mastery of the principles of military management, for example, is facilitated by the knowledge of the principles of individual behavior, group dynamics, and communication.

4.2 The Specification and Sequencing of Micro-Objectives

The micro-objectives (or "terminal objectives") identify the specific learned behaviors which the student is expected to accomplish as a result of the instruction. The micro-objective closely fits Mager's (1962) definition of a behavioral objective as an "intent communicated by a statement describing a proposed change in a learner -- a statement of what the learner is to be like when he has successfully completed a learning experience."

It is important to recognize the critical relationships between macro- and micro-objectives. A macro-objective, although by itself a rather general description of achievement, is exactly defined by the set of micro-objectives comprising the topic unit. The macro-objective may then be considered as a "summary statement" of a number of content-related micro-objectives. An example of each type of objective, in its relation to each other and to content, might be:

MACRO-CONTENT (PART): Communication

MACRO-OBJECTIVE: the student will be able to demonstrate the ability to communicate effectively.

MICRO-CONTENT (SEGMENT): Second principle of communication.

MICRO-OBJECTIVE (TERMINAL OBJECTIVE): Given a list of hypothetical situations, the student will demonstrate his understanding of the second rule of communication by selecting the appropriate situation in which it would apply.

The micro-content and terminal objectives are being derived from the content provided by the SME. Since this content is largely a description of the principles (rules) of leadership, the terminal objectives are statements of the students' expected in-depth acquisition of these principles; the objectives are emphasizing three major types of capabilities:

a. The student will demonstrate his knowledge of the rule by being able to discriminate a statement of the rule from a number of alternatives.

b. The student will demonstrate his understanding of the rule by being able to generalize the rule in a given situation.

c. The student will demonstrate his ability to apply the rule by using it in problem solving situations.

Some advantages of specifying the terminal objectives in this way, in addition to those already mentioned, are:

a. The micro-objectives will require the student to "do" something which can be observed and measured.

b. The micro-objectives will lend direction to the sequencing of the segment content and sequencing of presentation variations within segment instruction.

c. The micro-objectives can be tested by a number of test items which involve discrimination and generalization as well as problem-solving abilities.

d. Tests of the micro-objectives will provide valid and reliable estimates of the effectiveness of segment presentation.

e. Tests of the micro-objectives make it possible to pinpoint the student's specific areas of difficulty in learning materials.

Within the Parts, the terminal objectives are usually achieved independently; i.e., they are not hierarchically arranged.

4.3 The Specification and Sequencing of Enabling Objectives

An individual terminal objective (T.O.) only partially defines a macro-objective, and therefore, is by comparison a relatively small unit of behavior. However, by itself a T.O. represents a sizable achievement, requiring a number of prerequisite competencies for its accomplishment. Since these prerequisite competencies "enable" the student to achieve the final terminal behavior, they are called, appropriately, enabling objectives (E.O.).

The analysis of each terminal objective - which entails the specification and sequencing of its enabling objectives - is one of the most difficult, most elaborate, and most important tasks in the organization of the Leadership Course. It is in this task that the theory which we have been discussing finds its most effective application, because the sequence of the instructional

procedures is derived in large measure from the sequence of enabling objectives.

Suggestions from six different theories have contributed to the rationale for the specification and sequencing of enabling objectives:

1. Gagne (1965) has stated that complex, learned behaviors are built up from more simple behaviors. Since most of the terminal objectives are at the Type 7 (Principles) and Type 8 (Problem Solving) levels, one facet of the task is to specify the enabling behaviors in terms of Gagne's learning types. The analyses completed thus far have indicated that the enabling objectives are arranged in a hierarchy within each terminal objective.

2. Bloom's (1965) taxonomy has also been used in the analysis of the terminal objectives. Bloom's major categories of educational objectives (knowledge, intellectual abilities, and skills) have served as the basis upon which the T.O's are measured; the student will demonstrate his mastery of each T.O. by being able to discriminate the rule, generalize from the rule, and solve problems by applying the rule. Each of these requirements indicate the content and form of many of the enabling objectives.

3. Briggs' (1968) discussions of course structure based on hierarchies of competence have also contributed to the construction of the E.O. sequences.

4. The RULEG system, proposed by Evans, Homme, and Glaser (1962), has contributed procedures for analyzing the T.O's and E.O's in terms of their rules and examples. This method also considers the hierarchical nature of learning based on the type of discrimination and generalization required.

5. Gilbert's (1962) competition-facilitation analysis has been used extensively in the designation of the enabling objectives. This procedure deals with other elements of transfer besides hierarchical facilitation. It is essentially an analysis of behavior domains in which discrete components of subject matter are identified and grouped. Gilbert's methods suggest which behaviors should be taught together, which should be taught separately, and the general ordering of the instruction.

6. Tosti and Ball's (1969) media selection model has considered the importance of planning the sequence of instruction. These authors have included sequence within the "distribution" dimension of presentation. This dimension refers to "the ordering, grouping, and sequencing of behavioral items and the temporal spacing between such items. Distribution includes such items as the distribution of practice, the frequency of review, and the hierarchy of content presentation." Describing the concept of behavioral hierarchies, Tosti and Ball (1969) write:

> It is known that behavior which can be built onto already existing behaviors is generally facilitated in its acquisition, retention, and generalization. This is one of the primary differences between the application of modern behavioral theory and the application of behavioral theory in the twenties. Thus, if a new stimulus-response (S-R) pair is going to be installed, it would be most advantageous to have certain other S-R pairs previously established. Of course, such antecedent behaviors may have been established before the instructional setting, or the distribution decision to create and establish such behaviors within this instructional setting might be made before the establishment of the new behavior. There are several classes of such behaviors which must be considered. These include stimulus discrimination, response differentiation, existence of mediators such as understanding, analogy, or mnemonic, and those response sets concerned with observing and covert responding sequence.

The specification and sequencing of the terminal and enabling objectives is presently being completed by WLC, based on the theoretical positions we have just described.

5.0 Summary and Conclusions

WLC has been using the suggestions from a number of psychological and educational theories in the development of the content into a well-organized and properly-sequenced course of instruction.

One stage in this development has been the specification, on three levels of behavioral complexity (macro-, micro-, and enabling objectives), of those behaviors which were considered to be functionally related to each other. Intensive content analysis, which began with the restatement of the subject matter in terms of behavioral objectives, has resulted in the conclusions (1) that the general course structure was best represented as a hierarchical arrangement of macro-objective; (2) that the macro-objectives were defined by a set of relatively independent terminal objectives; and (3) that the enabling objectives could be arranged in a hierarchical sequence within each terminal objective.

The content sequence is now being completed by WLC. It is expected that this planned sequence will substantially facilitate the instruction of the Naval Leadership Course.

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